Appendix-A

Steady State Case Development

1. *Case Development*

Minor changes are made to basecase to improve representation of the Buffalo Ridge area in Minnesota, which is assumed to include a total 825 MW of wind generation and associated transmission reinforcements. The description of the important changes made to basecase is listed below.

1. Transmission Upgrades Associated with 825 MW Wind Generation in the Buffalo Ridge Area Buffalo Ridge 425 MW Generation Outlet Series Projects (Page 91 of midwestiso.org > planning and interconnections > MTEP 03 June 19,2003)

- Wilmarth-Lakefield Gen Upgrade to 100 Conductor Temp (1165 MVA)
- Lakefield Jct-Fox Lake 161 kV #2 – construct new circuit
- Minn Valley 230/115 kV tx (100 MVA) - Replace with 187 MVA unit
- Summit-Dome Tap-Loon Tap 115 kV – Reconductor 25 Miles
- Willmar 115/69 kV tx – Replace with 112 MVA Unit
- Alexandria-Douglas Co. 115 kV – Reconductor 11 miles
- Fox Lake-Rutland 161 kV – Rebuild 18 miles + Rutland-Winnebago – 16 Miles (825MW Project)
- Paynesville-Wakefield 115 kV – Reconductor 15 miles
- Elbow Lake-Grant Co. 115 kV - Reconductor
- Willmar-Kerkhoven 115 kV – Rebuild
- Franklin-Birch-Henry-Bird Island 69 kV - Rebuild
- Troy 69 kV Switching Station – Install Switching Station
- Chanarambie-Ellsborough-Lake Yankton 115 kV – 26 miles new line
- Lk Yankton-Lyon Co. 115 kV – 30 miles new line
- Lyon Co. 115/69 kV Substation – Four 115 kV line terms, 70 MVA 115/69 tx, two 69kV line terms
- Lake Yankton Sub – Install 115 kV ring bus, line terms, 115/34.5 kV tx, and dynamic VAR compensator

2. Buffalo Ridge 825 MW Generation Outlet Series Projects (Page 93 of midwestiso.org > planning and interconnections > MTEP 03 June 19,2003)

- Split Rock-Nobles Co.-Lakefield Junction 345 kV – 94 miles new line
- Nobles Co 345/115 kV Sub – New sub with 448 MVA tx+Nobles Co-Fenton-Chanarambie 115 kV
- Buffalo Ridge-Yankee-White 115 kV – 26 miles new line
- Brandon-Elbow Lake 115 kV – Reconductor 17 miles
- Paynesville 230/115 kV tx – Install 336 MVA Unit
- Minn Valley-Redwood Falls Tap-Franklin 115 kV – Reconductor 41 miles
- Black Dog 230/115 kV tx – Replace 187 with 336 MVA unit
- Paynesville-RoscoeTap-Munson 69 kV – Rebuild 11.6 miles
- Douglas Co.-Long Prairie 115 kV – Reconductor 19.3 miles

3. Wind Ratings for Existing 115 kV Circuits

- Split Rock-Pathfinder; a minimum 240 MVA rating (2ft/s).
- PathFinder-Pipestone, a maximum 225 MVA rating (8.8 ft/s)
- Pipestone-BuffaloRidge, a maximum 292 MVA rating (22 ft/s)

- BuffaloRidge-Lake Yankton, a maximum 292 MVA rating (22 ft/s)
- Lake Yankton-Lyon County #1, a maximum 274 MVA rating (17.6 ft/s)
- Lyon County-Minnesotta Valley has a minimum 157 MVA rating and a maximum 225 rating wind ratings.
- Chanarambie-Pipestone, a maximum 384 MVA rating (22ft/s)

After establishing the base power flow case, the proposed wind generation project was added each of the seven locations. A single substation transformer is assumed to interconnect DFIG to collector bus and its ratings for different size of wind generation interconnection are tabulated below.

Table 1-1 Substation Transformer Ratings and Parameters

Substation Transformer Parameters	Units	Option 0 500MW	Option 1 375MW	Option 2 250MW	Option 3 150MW	Option 4 50MW	100MW
Rate A	MVA	600	450	300	200	60	125
Rate B	MVA	650	500	350	225	70	150
Transformer R	Pu	0.5	0.5	0.5	0.5	0.5	0.5
Transformer X	Pu	12.5	12.5	12.5	12.5	12.5	12.5
LTC	%	+/-5%	+/-5%	+/-5%	+/-5%	+/-5%	+/-5%
Tap Size	%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%

Bus numbers, voltage levels and basecase voltages of collector buses for all seven sites are listed in Table 1-2.

Table 1-2 Collector Bus Details at Seven Sites

Location No	Interconnecting Site	Coll. Bus No.	Coll. Bus kV	Area No.	Zone No.	34.5kV Bus No.	Coll. Bus Voltage (pu)
Loc. 1	Garrison	66441	230	652	90	6441	1.030
Loc. 2	Pickert	66759	230	626	90	6759	0.983
Loc. 3	LelandOlds-Groton (Ellendale)	*2222	345	652	659	1111	1.017
Loc. 4	New Underwood	66484	230	652	653	6484	1.007
Loc. 5	Mission	66482	115	652	653	6666	0.994
Loc. 6	Ft. Thompson	66506	345	652	654	6111	1.044
Loc. 7	White	66537	345	652	654	6537	1.041

Note: * A duplicate bus created at 50% of Leland-Groton 345kV (67105 - 67160) line length.

Analysis is started with 500 MW at each site, identified the system enhancements and then goes to the next lower level of generation in sizes of 500MW, 375MW, 250MW, 150MW and 50MW. Developed cases for different sites are solved with FDNS with phase shifting, tap changing, switched shunts and DC line control options open.

Case names are defined with first digit indicating location number and second digit indicating option number for interconnection, i.e. Case 10 represents interconnection of 500MW at Garrison.

Case 8 is developed with 100MW of wind generation interconnection at Garrison, Ft. Thompson & White and all remaining four sites are connected with 50MW of wind generation.